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Published in:
Physiological Measurement

DOI:
10.1088/0967-3334/35/11/2329

Publication date:
2014

Document Version
Early version, also known as pre-print

Title

Objective assessment of intensity categorisation of the Previous Day Physical Activity Recall questionnaire in 11-13 year old children

Short title

Objectively assessed PDPAR in children

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Key words: previous day physical activity recall, objective activity monitoring, adolescent, accelerometer

Word count: 4195

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Abstract

The Previous Day Physical Activity Recall (PDPAR) self-report questionnaire asks children to categories their time in 30-minute blocks under activity codes and activity intensity (ActInt). Text and visual descriptors of ActInt are used which include posture and stepping intensity. This study aimed to objectively examine postures and stepping activity associated with PDPAR ActInt . Forty-three (19M/24F) 11-13y children completed the PDPAR and wore a physical activity monitor (8d). Within 30-minute blocks the % sitting/lying, standing and stepping, steps, cadence and sit-to-stand transitions (STS) were examined by PDPAR ActInt across and within all activity codes. Data (14083 30-minute blocks) showed from light to moderate ActInt lower sedentary time, higher standing and stepping time, steps, sit-to-stand transitions and cadence (all $P<0.001$). Between moderate and hard ActInt, time sedentary was lower and time stepping, steps and STS higher (all $P<0.005$). No significant differences between hard and very hard. There was a wide variation of activity levels between activity codes within ActInt. ActInt within the PDPAR was not used consistently between activity codes. However, over all codes children demonstrated that they could distinguish between light and moderate and in some objective measures between moderate and hard, but not between hard and very hard ActInt.

Key words: previous day physical activity recall, objective activity monitoring, adolescent, accelerometer

Submitted to Physiological Measurement ICAMPAM2013 Focus Issue

Title

Objective assessment of Previous Day Physical Activity Recall questionnaire activity intensity categorisation by 11-13 year olds

1. Introduction

The Previous Day Physical Activity Recall questionnaire (PDPAR) (Weston et al, 1997) is a validated questionnaire (Anderson et al (2005), McMurray et al (2004), Trost et al (1999), Trost et al (2007)) for assessing the physical activity (PA) of children and adolescents primarily in relation to energy expenditure estimation. It is a subjective, self-report questionnaire which records the predominant activity performed within 30-minute time segments. Participants are requested to choose their main activity from a predetermined list of coded activities as well as selecting the intensity at which they believed they were working for this activity. The questionnaire has been used to estimate energy expenditure and time spent in moderate and vigorous activity.

Validation of the PDPAR has previously involved the comparison of questionnaire outcomes against objective measures (Foley et al 2012). This has followed the original purpose of the questionnaire, which was to estimate energy expenditure (Weston et al 1997). For each activity classification reported by participants, an energy expenditure estimate (based on an assigned metabolic equivalent of task or MET level) is used to develop an overall energy expenditure for the entire day. Weston et al (1997) used pedometers, accelerometers (Caltrac Personal Activity Computer, Hermokinetics, Madison, WI) and heart rate monitors (Polar Vantage XL; Polar CIC Inc, Port Washington, NY) to develop an understanding of the meaning of outcomes in terms of energy expenditure. Pearson correlation coefficients between pedometer, Caltrac and PDPAR were 0.88 ($p<0.01$) and 0.77 ($p<0.01$) respectively, with the correlation between percentage heart rate range (HR_{max}- HR_{-rest}) and mean energy expenditure from the PDPAR of 0.53 ($p<0.01$) (Weston et al 1997). These results indicate that the PDPAR outcomes are related to step count, accelerometer based movement counts and measurements of heart rate. However, these relationships were not strong, indicating considerable variability in use of the categorisation within the PDPAR. Similarly Anderson et al (2005), examined objectively measured time in moderate and vigorous physical activity (MVPA) (MTI accelerometers) against PDPAR outcomes reporting correlations of $r\sim0.4$, but reporting substantial variation in outcomes based on the choice of accelerometer cut points. Trost et al (1999) used accelerometers (CSA WAM 7164) recording a correlation of $r=0.57$ between

PDPAR self-report determined MET level and total counts for 30 minute blocks. Trost et al (2007) used pedometer step counts (Digiwalker, Yamax, Japan) giving a correlation of r=0.34 with mean MET level and r=0.29 for the number of 30 minute blocks of MVPA as calculated from PDPAR outcomes. McMurray et al (2004) reported a correlation of r=0.31 between time in MVPA derived from PDPAR and Actigraph counts. Tucker et al (2011) reported that a 30 minute period of activity rated as MVPA within the PDPAR (based on the compendium of physical activities; Ainsworth et al., 2000) was equivalent to only 9.0 minute for males and 4.2 minutes for females of MVPA as measured using an accelerometer (Biotrainer). The focus of these previous validation studies has been to assess the relationship between PDPAR reported activities and energy expenditure. Whilst these previous studies, which have used objective measurement, provide some insight into the way participants use the PDPAR intensity categories, they do not examine the interpretation that is placed on the definitions used for the categories: The categories of intensity are defined using references to posture (i.e. sitting or standing) and to stepping, with different cadences. Accelerometer counts do not relate directly to posture or stepping activity. Pedometer outcomes clearly relate directly to stepping, but few such instruments will provide an estimate of stepping intensity, i.e. cadence.

To date no attempt has been made to examine posture and stepping activity associated with the PDPAR activity intensity categories. To do this an objective measurement device capable of characterising posture and stepping activity must be used. One objective measuring device that can characterise posture and stepping activity against a time line is the activPAL (PAL Technologies Ltd. Glasgow, UK) activity monitor. The activPAL has been shown to be an accurate, valid and reliable device to measure free-living PA and postural related movement in a variety of populations (pre-school children (Davies et al 2012); adolescents (Dowd et al 2012); young adults (Harrington et al 2011); healthy adults (Dahlgren et al 2010; Godfrey et al 2007; Grant et al 2006, Ryan et al 2006); older adults (Grant et al 2008)). If it could be demonstrated that children use the PDPAR consistently to report posture and stepping activity its strength as a tool to inform intervention planning would be enhanced.

The aim of this study was to explore the posture and stepping activity associated with PDPAR activity intensity classification by children between the ages of 11 and 13 years old. This relationship was examined by comparing self-reported activities and intensities with objectively measured postural state and stepping activity as recorded by an activPAL monitor. This new insight into posture and stepping activity associated with activity intensity across 30-minute time periods will help to inform the interpretation of PDPAR outcomes.

2. Methods

2.1 Participants

A convenience sample of 43 pupils was recruited from a Scottish state high school in a town with population of ~5700 and average commuting distance to school of 5.6km (SD 2.5, range 1.1-10.9km). Demographic details including age, sex and body mass index were recorded. Participants were excluded from analysis if functionally dependent (e.g. wheelchair user) or suffering impairments in mobility (e.g. pain whilst walking or any musculoskeletal injury). Ethical approval was obtained from Glasgow Caledonian University Ethics committee, North Ayrshire Education Authority and the participating school.

2.2 Physical activity measurement

Measurement of PA was performed at two distinct time-points. Data collection from all participants for up to 8 days in both November/December and May/June ensured that data was representative of winter and summer seasons. Data was collected over weekends and weekdays, where schooldays started at 09:00 and finished at 15:25.

Subjective measurement

The Previous Day Physical Activity Recall (PDPAR) questionnaire was used to record participants' subjective reporting of PA. The questionnaire was completed every morning by the participants. This was supervised on school day mornings, but performed unsupervised at the weekends. Specifically the participants were instructed:

'For each time period (of half an hour) write in the activity number which corresponds to the main activity you actually performed during that particular time period' …..

'then rate how physically hard each activity was….'

The activity codes available are listed in Table 1 and were broadly sub-categorised into: Eating, Work, Out of School/spare time/hobbies, Transport, Sleep/bathing, School, Physical activities and sport.

Four intensity levels were available as detailed in Table 2. Each intensity level was described to the participants using a text statement and a primary visual reference. Whilst both text and visual reference were reproduced

within the overall questionnaire that the participant had access to, only the visual references were placed at the head of the columns which had to be ticked indicating the intensity level. Therefore, whilst both the text statement and the primary visual reference were shown to the participants, only the primary visual reference was present when the intensity levels were being recorded.

The version of the PDPAR used within this study was modified to reflect cultural differences in sport and exercise engaged within Britain compared to the United States (i.e. code 45 using football instead of soccer and code 43 including rugby instead of American football). It was also adapted to include a greater portion of the day (07:00 – 24:00) instead of only after school hours (the original (Weston et al 1997) aimed only to examine after school activity from 15:30 – 23:30). This extension of time was implemented to gather information on the whole of the waking day. This gave a total of two 30-minute periods for 17 hours of the day, i.e. 34 30-minute periods per day.

Objective measurement

The activPAL professional activity monitor (PAL Technologies Ltd, Glasgow) was used to objectively measure PA in this cohort. This is a small (5 x 3.5 x 0.7 cm, 20g) anterior mid-thigh mounted device, incorporating a uniaxial accelerometer which uses proprietary algorithms to detect the postural elements of PA (sitting/lying and quiet standing) as well as stepping. For each 30-minute time period the outputs from the activPAL proprietary software were used to determine the % time sedentary, standing (not stepping) and stepping, and the number of sit-to-stand transitions. Also the number of steps taken and their average cadence was calculated for the 30-minute time period.

Participants were given instructions as to how to wear the monitor and how to reapply it if removed. Proprietary adhesive hydrogel pads (PALStickies) were supplied for monitor attachment with additional elasticated bandage to offer greater support. Following monitor application, participants were free to continue with their usual daily activities, with instructions to wear the monitor 24 hours a day for over seven days, only removing it for water based events (e.g. shower, swimming) or activities such as sports deemed a potential risk to the wearer (forceful contact in sports such as rugby or falling in skiing/snowboarding) or the monitor.

2.3 Analysis

All data from all participants across the period of data collection were considered for used in the analysis. The first day was used to account for "reactivity" (Cleland et al, 2008) and was not used in the analysis. Data outputs were used to identify periods of non-compliance with monitor wear. Where objective data did not appear to reasonably match subjective data (e.g. where participants subjectively reported very hard intensity, but no activity was recorded by the activPAL) this was considered non-wear and data was removed for this time period and the time period immediately before and after.

For every 30-minute block (half-hour time period), the objective outcome (% sedentary, % standing, % stepping, sit-to-stand transitions and cadence) was matched to both the activity code and subjectively rated activity intensity of that same 30-minute block. Objective measurement data sets were not normally distributed (Kolmogorov-Smirnov). Therefore, independent sample Kruskal-Wallis H tests were used to compare the distribution of these objective outcomes across the subjectively reported activity intensities. Subsequently, Mann Whitney U tests with Bonferroni corrections were performed to identify specific inter-intensity differences ($p<0.05$).

To reduce the effects of small numbers on reported outcomes, within specific code/intensity category combinations, only those codes for which more than 30 half-hour periods (across all intensities within the code) were successfully recorded were analysed further. Also of the codes with more than 30 half-hour periods, only intensity categories with more than 5 half-hour periods (within intensity category within the code) were considered.

3. Results

Matched PDPAR and activPAL data were obtained for 43 children (19M/24F) across the winter and summer time points. Across all data collection points the age range of participants was from 11.67 to 13.16 years (mean 12.49, SD 0.36) with mean height 154.3cm (SD 7.8, range 140.0-174.8cm) and weight 47.6 kg (SD 47.6, range 33.0-74.0kg). BMI ranged from 14.6 to 34.0 kg/m^2 (mean 19.8, SD 3.7). Compliance with questionnaire completion and monitor wear was variable, resulting in a mean of 331 (SD 105, range 68 to 487) 30-minute periods per participant. This resulted in a total of 14083 30-minute blocks of matched data across all participants, equivalent to 414 days.

The majority of reported time periods were within the light intensity category (11484 half-hour periods), then moderate (2010 half-hour periods), hard (461 half-hour periods) and very hard (128 half-hour periods) (Table 1) with decreasing occurrence. Of the codes available for selection some were not selected at all: 'Religious prayer', 'badminton', 'table tennis', 'netball', 'skateboarding', 'volleyball', 'weights/circuit training'. Of the remaining codes some were selected in only a small number of cases (<30): 'Garden work', 'church/temple/mosque', 'travel by bicycling', 'other way of travel', 'aerobics/aerobic dancing', 'basketball', 'bowling', 'hockey', 'wall-climbing', 'roller-skating/roller blading', 'softball/rounders', 'stationary exercise machines', 'swimming water exercise', 'tennis'.

There were large differences in the intensity categorisation between codes (Table 1). For example 1064 30-minute periods of light intensity activity were reported for 'playing computer/computer games/surfing internet' and only 44 at moderate intensity with none at hard or very hard. In comparison the majority of 'jogging/running' was reported as either moderate (28), hard (51) or very hard (10), with only 6 at light intensity. The categorisation appeared to be as expected with the more sedentary type of activities, e.g. 'homework/tuition', 'listening to music', 'watching TV or movies' etc., tending to be categorised as light and the physical activities and sports tending to have higher intensity ratings.

When all matching periods were grouped and examined by intensity category it was observed that all objective outcome measures were significantly different ($p<0.001$ in all cased) between categories of light and moderate (Table 3). The % sedentary reduced, % standing and % stepping increased along with increasing number of steps taken (Figure 1). Also the number of sit to stand transitions (STS) increased along with mean cadence of steps taken. Additionally between moderate and hard categories % sedentary reduced ($p<0.001$) and the % stepping ($p<0.001$) and associated steps increased ($p<0.001$) and STS increased ($p=0.004$). However, there was

no difference in the % standing, or cadence between moderate, hard and very hard. There were no significant differences between hard and very hard intensity categories when all codes were considered together.

When examined by code it was observed that there were differences within intensity categories between codes (Table 3). For example at light intensity the median % sedentary for 'free periods/break time' (code 26) at 40% was half that of sitting in class (code 27) at 80%. Large differences were also observed at light intensity between codes for the number of steps taken with median range of 0 ('sleeping' code 24) to 1017 ('travel by walking' code 18).

The distinction between intensity categories within codes was not as clear as that observed overall: For some codes there were significant differences between the light and moderate intensity categories for stepping time and number of steps taken (e.g. 'eating a meal' code 1, 'handing around' code 8 and 'sitting in class (lesson time)' code 27), whilst for others there was not (e.g. 'snacking' code 2, 'homework/tuition' code 9 and 'riding in a car/bus' code 17). Of those activities were more than 30 periods were reported only five had more than 5 in the hard intensity category ('PE class' code 28, 'dance' code 35, 'jogging/running' code 41, 'football' code 45, 'walking' code 51) and only 4 in the very hard intensity category (as for hard intensity except not 'dance' code 35). All of these codes were within the physical activities and sports section. There was considerable variation in the occurrence of significant differences between the moderate, hard and very hard intensity categories by code. Of particular note was the high level of stepping with high cadence for 'jogging/running' code 41. However, the reporting of hard intensity for this activity was not associated with higher numbers of steps than moderate or light intensities.

4. Discussion

The PDPAR is a self-report questionnaire and can, therefore, be used with little financial outlay and can be used on a large scale. However, it is important to know how participants use the codes and intensity categories when completing this questionnaire.

Previously it has been demonstrated that the relationship between PDPAR outcomes and energy expenditure has low correlation when measured using heart rate monitors (Weston et al 1997). Pedometer outcomes and those generated using accelerometers demonstrated closer correlations, but overall there is a lack of evidence of a

strong relationship between energy expenditure and PDPAR outcomes (Anderson et al 2005, McMurray et al 2004, Trost et al 1999, Trost et al 2007).

The estimation of energy expenditure from the PDPAR requires the specification of MET equivalents for each of the code/intensity combinations. Weston et al (1997) provided a list of MET values that could be applied to the activity codes and intensity levels. These varied within intensities between codes. MET values for a range of activities have been compiled (Ainsworth et al 2000, Ainsworth et al 2011) providing a means of converting self-reported activities to energy expenditure estimates. The application of these, across the populations studied, has provided group based outcomes that might be considered acceptable (see previous correlations) if population level outcomes are desired. However, there is a possibility that reporting only overall outcomes (e.g. Tucker et al (2011) report the average of all outcomes across three days) masks inaccuracies of energy expenditure allocation within particular code/activity intensity categories. To better comprehend what study participants are actually doing an understanding of the activity within code/activity intensity categories is essential. Tucker report that a 30 minute period of MVPA as categorised using the PDPAR is actually only equivalent, on average, to 9 minutes of MVPA for males and 4.2 minutes for females as measured using accelerometry. This indicates that the PDPAR MET equivalent rating only provides a limited understanding of the activity actually being performed. The examination of postural state and stepping activity associated with the reporting of particular codes/activity intensities helps develop understanding of how the PDPAR is being used. This is particularly important as one aspect of the PDPAR tool that is designed to help guide accurate completion is the presence of visual and text references to describe the activity intensity levels. These do not change between codes and it might be expected, therefore, that participants would rate similar levels of stepping or sedentariness similarly between codes. Whilst the text references provided indications of how activity should be classified based on breathing rate coupled with movement they did not explicitly indicate 'stepping activity' or 'standing' (Table 2). This was in contrast to the visual references which explicitly indicated posture and stepping. This difference could potentially have caused difficulty for the participants interpreting the questionnaire. The inclusion of both text and visual references were aimed at clarifying the expected interpretation of activity intensity and participants had access to both, so it might be assumed that they would have used both of them to help classify their activity under different intensity levels. The original purpose of the PDPAR was to estimate energy expenditure levels, for which the text reference descriptions of activity intensity would be appropriate. However, it was clearly considered appropriate to add visual references as it was felt

these would help children interpret the text references. The result is that is it not possible to say for certain which the children were using during their completion of the questionnaire.

The current study has demonstrated that in general the participants (11.67-13.16 years) did identify the intensities of light and moderate with different postural and stepping activity levels. The visual images used to define these categories were clearly distinct, with light being seated and moderate being upright. A significant difference in % sedentary would, therefore, have been expected and was observed. However, with the text descriptions of moderate as 'Normal breathing with some movement' it might not be expected that high proportions of this time might be stepping activity. However, over all records where moderate was reported participants were stepping for 20% of the time.

Between moderate and hard the visual distinction was of a change from static standing to purposeful stepping. This was reinforced by the text description 'increased breathing and moderate movement' for the hard intensity category. Overall this was reflected in PDPAR intensity categorisation with the hard category having significantly increased stepping time and steps compared to the moderate intensity category outcomes.

The difference between hard and very hard was characterised by a visual distinction of increased stepping rate and a text description of 'hard breathing and fast movement'. However, this did not translate into a difference in objectively measured outcomes for these participants. It is possible that this was due to a lack of perceived distinction between the two categories for this population.

The large difference in the outcomes by activity code (Table 3) demonstrated that participants did not classify activity intensity consistently between codes. An example of this is for code 18, 'travel by walking'. It appears that participants were performing a rating of intensity within this code. The number of steps taken for activity designated as light, at a median of 1017 per 30 minutes, was considerably higher than most other codes and is contrary to the visual and text descriptions given. The difference in this code between light and moderate intensity activity was for % standing which was higher for light at 16% than moderate at 27%, but with no change in steps taken between categories.

In general activities that are understood to have lots of sedentary time associated with them, e.g. 'homework/tuition', 'listening to music', 'playing computer/computer games/surfing internet', 'reading', 'watching TV or movie', 'sitting in class' (codes 9, 10, 12, 13, 16, 27 respectively) all had high levels of % sedentary, i.e. >=80% for light activity. Where these activities were allocated a moderate intensity

categorisation they also had a high level of % sedentary, above 70%. This again indicates that perhaps the participants were performing an intensity classification within codes and not being consistent across codes. It is also conceivable that participants were recording an 'average' activity intensity across the 30-minute period: Taking into account the fact that 'very hard' activity was only performed for a proportion of the 30-minute period giving a reported outcome at a lower activity intensity categorisation.

Weston et al (1997) provide MET equivalent values for the code/activity intensity combinations. The MET levels assigned to activity intensity codes are quite different between codes even though the text and visual references are not. For example in the moderate activity intensity watching TV is assigned 1.5 MET compared to jog/run of 6.0 MET. The results reported here, confirm that the participants did use the activity intensity levels differently between codes despite the fact that the text and visual references were identical.

The PDPAR is a self-report questionnaire and relies on the participants answering honestly and with accurate recall. The objective measures reported here provide some insight into the variability of the interpretations used by the participants, both within and between activities. It is possible that this was due to individual's interpretation, however, it is also possible that these differences reflect the requirement to describe the 'main' activity within 30-minute time periods. It is possible that this does not match the activity patterns of children at this age. A clear indication of this is within the 'walking' code 51. To walk continuously for 30 minutes at a cadence of 80 steps a total of 2400 steps would be taken. The median steps taken indicated for 'walking' was highest in the hard category at 944 steps. In the 'jogging/running' code 41 a maximum median is seen in the very hard intensity category of 1897 steps. If stepping had been continuous at the median cadence of 102 then a total of 3060 steps would have been expected. These results clearly illustrate that the 30 minutes was not continuous stepping in either case. It is clear from the objective measures that over 30% of time for even the very hard intensity categorisation was spent either sitting or standing without stepping.

The requirement to complete the questionnaire against a rigid time line may have influenced the outcomes. For example if an activity, e.g. walking to school ('travel by walking' code 18), lasted less than 30 minutes, crossed the border of one of the 30 minute time periods or lasted slightly longer than 30 minutes, it is not possible to accurately characterise this activity with the PDPAR.

This study provides new insight into the way in which children characterise their usual daily activity using the PDPAR, however, there are several limitations to this study. The participants were selected only from one school and whilst data was recorded across seasons a wider sample should be examined to ensure

generalisability. Some of the codes were poorly represented within the study population perhaps reflecting cultural norms within this group. The completion of the PDPAR at the weekend concerning the previous day was unsupervised. This could have introduced errors with participants reporting that they had made timely completions of the PDPAR but actually having completed it late. McMurray et al (2004) demonstrated markedly lower correlations between PDPAR and accelerometer outcomes for recall from 2 days previously compared to previous day, suggesting that timely completion is essential to ensure reliable results.

5. Conclusion

The activity intensity categorisation as presented in the PDPAR could be used by 11-13 years olds to report differences between light and moderate activity intensity when considered across all activity codes. There was also objective evidence that the participants could distinguish between moderate and hard intensity in terms of time spent stepping and steps taken. However, there was not a clear distinction reported between the hard and very hard categories.

Between activity codes there was inconsistency of reporting, suggesting that, in the context of the PDPAR, 11-13 year olds view intensity of activity differently between different activities confirming the suitability of using different MET level assignments between codes.

This examination of posture and stepping activity using objective measurement has highlighted the need to take a cautious approach to interpreting intensity outcomes from the PDPAR at a code level, although across all reported data there were objective differences between light, moderate and hard activity intensity levels demonstrating that this is a useful tool for characterising physical activity engagement in this context.

Acknowledgements

The authors would like to thank the participating school, staff and pupils for their help, assistance and participation in the study. In particular, the assistance of Melanie Cunningham, Julie McCafferty, and the four senior pupils during the data collection was invaluable.

Conflict of interest

M Granat has a financial interest in PAL Technologies Ltd, the manufacturer of the activity monitor used in this study.

Funding

This study was supported by Glasgow Caledonian University, as part of a doctorate program within the School of Health and Life Sciences.

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a)

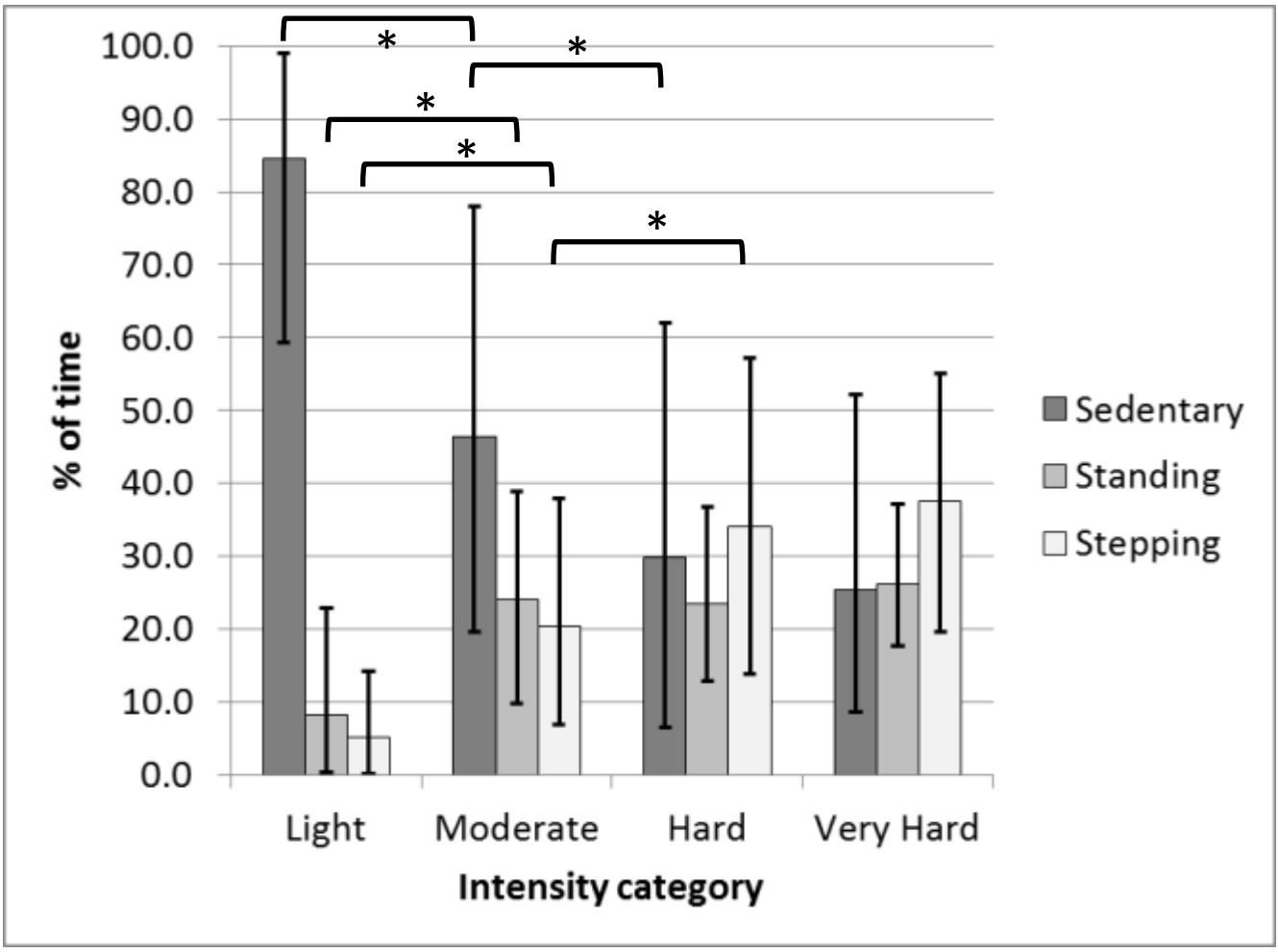
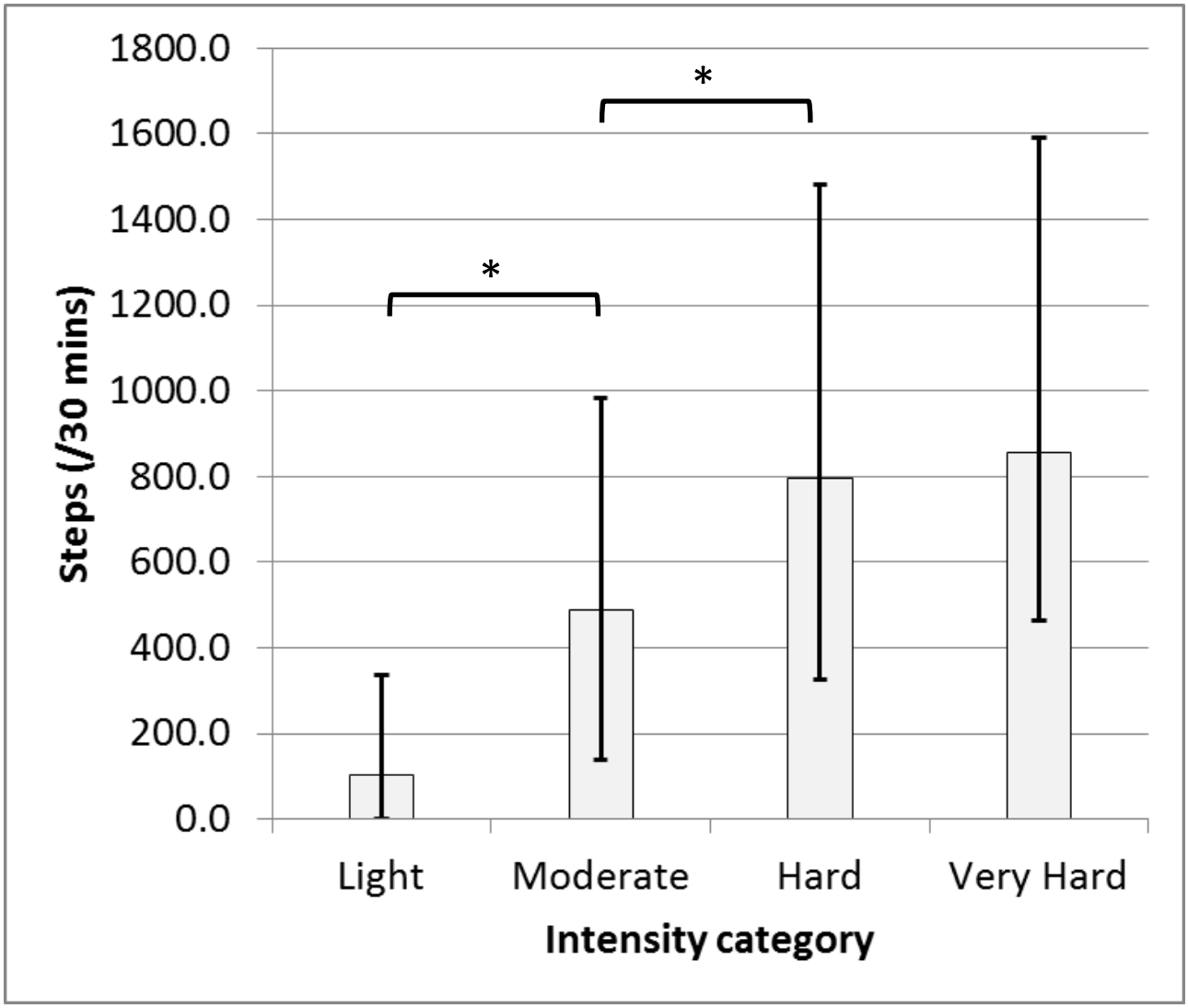


Figure 1 Overall outcomes by intensity category. The median value, 25th and 75th percentiles of each outcome are given with significant differences highlighted. (a) Percentage of time in sedentary, standing and stepping. (b) Steps. (c) Sit to stand transitions. (d) Cadence. *P<.05.

b)



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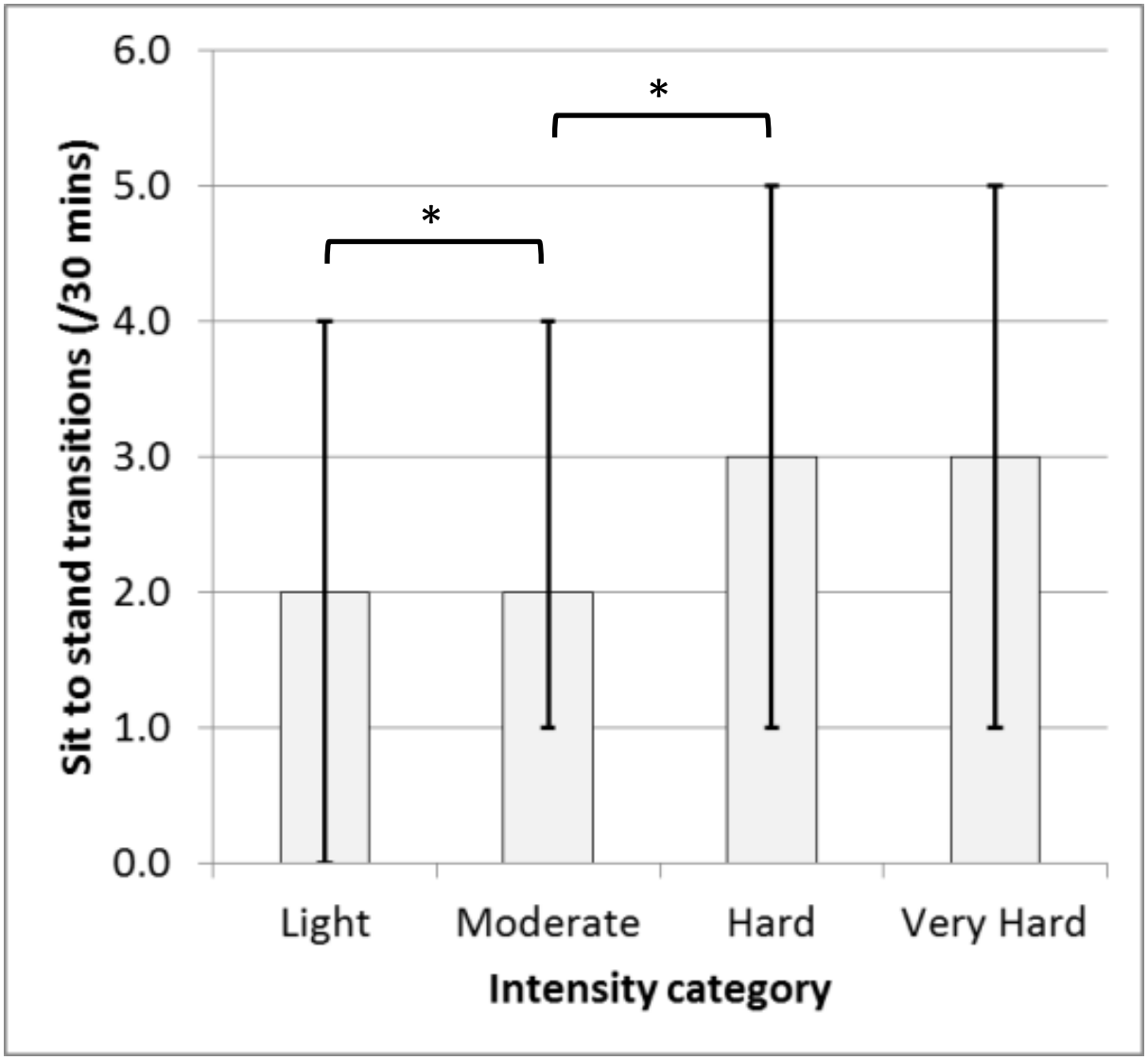
c)



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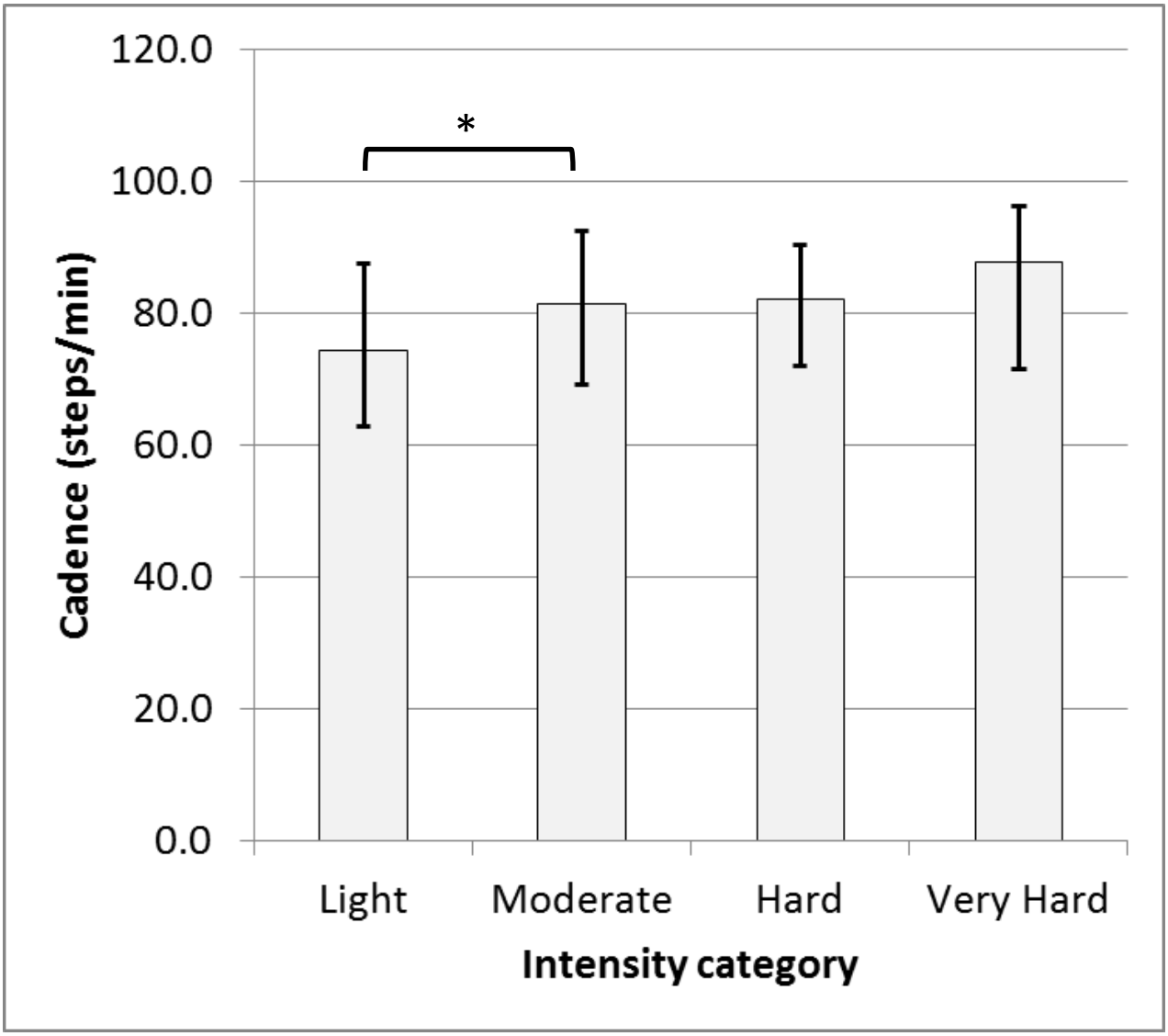

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Table 1 Activity codes available for selection. The total number of half hour periods for each activity across all participants is given with the number falling into each intensity category.

Category	Code	Activity	All	Activity Intensity			
				Light	Moderate	Hard	Very Hard
	All		14083	11484	2010	461	128
Eating	1	Eating a meal	675	652	22	1	0
	2	Snacking	244	230	14	0	0
Work	3	Working (eg paper round, p/t job, baby-sitting)	40	10	30	0	0
	4	Doing house chores (e.g. vacuuming, dusting, washing dishes, etc)	105	45	58	2	0
	5	Garden work (e.g. mowing, raking	25	4	18	3	0
Out of school/spare time/hobbies	6	Church/temple/mosque	13	9	4	0	0
	7	Religious prayer (e.g. Salat)	0	0	0	0	0
	8	Hanging around	608	406	201	1	0
	9	Homework/tuition	140	125	15	0	0
	10	Listening to music	215	212	3	0	0
	11	Music lesson/playing instrument	99	56	43	0	0
	12	Playing computer/computer games/surfing internet	1108	1064	44	0	0
	13	Reading	223	223	0	0	0
	14	Shopping	145	84	57	2	2
	15	Talking on phone	75	65	10	0	0
	16	Watching TV or movie	1628	1624	4	0	0
Transportation	17	Riding in a car/bus	695	675	19	1	0
	18	Travel by walking	229	37	189	3	0
	19	Travel by bicycling	6	0	0	0	6
	20	Other way of travel: list	5	5	0	0	0
Sleep/bathing	21	Getting dressed	401	354	47	0	0
	22	Getting ready (hair, make-up, etc)	223	196	27	0	0
	23	Showering/bathing	245	224	21	0	0
	24	Sleeping	1996	1996	0	0	0
School	25	Club (e.g. computer club), student activity	30	7	20	3	0
	26	Free period/breaktime	290	140	149	1	0
	27	Sitting in class (lesson time)	2971	2833	138	0	0
	28	PE class	155	16	50	66	23
Physical activities and sports	29	Aerobics/aerobic dancing	3	1	1	1	0
	30	Basketball	8	0	2	4	2
	31	Bicycling	103	0	23	66	14
	32	Bowling	1	0	0	1	0
	33	Badminton	0	0	0	0	0
	34	Table tennis	0	0	0	0	0
	35	Dance	38	6	23	9	0
	36	Hockey	2	0	2	0	0
	37	Wall-climbing	2	0	2	0	0
	38	Golf	19	0	5	8	6
	39	Netball	0	0	0	0	0
	40	Roller-skating/roller blading	1	1	0	0	0
	41	Jogging/running	95	6	28	51	10
	42	Karate/judo/martial arts	23	0	0	12	11
	43	Rugby	18	0	0	13	5
	44	Skateboarding	0	0	0	0	0
	45	Football	181	1	67	86	27
	46	Softball/rounders	2	2	0	0	0
	47	Stationary exercise machines (e.g. cycle, ski machine, stair climber, treadmill)	12	0	2	5	5
	48	Swimming, water exercise	19	0	5	10	4
	49	Tennis	4	0	0	4	0
	50	Volleyball	0	0	0	0	0
	51	Walking	634	67	506	50	11
	52	Weight/circuit training	0	0	0	0	0
Other	53	Other (list)	329	108	161	58	2

Table 2 Definitions of Intensity as given to the participants.

Intensity	Text reference	Primary visual reference
Light	Slow breathing, little or no movement	Person seated doing nothing
Moderate	Normal breathing and some movement	Person standing doing nothing
Hard	Increased breathing and moderate movement	Person upright and walking purposefully
Very Hard	Hard breathing and quick movement	Person upright and running fast

Table 3 Median outcomes for all and selected codes (see Table 1). Outcomes are presented by intensity category from light to very hard. Outcomes where significant differences between intensities were detected are shaded with different colours within codes. All unshaded outcomes were not different from other intensity outcomes. Outcomes are only given where more than 5 half hour blocks within each intensity category were recorded.

	Light						Moderate						Hard						Very Hard					
Activity [code]	Sedentary (%)	Standing (%)	Stepping (%)	Steps (/30mins)	STS (/30mins)	Cadence (steps/min)	Sedentary (%)	Standing (%)	Stepping (%)	Steps (/30mins)	STS (/30mins)	Cadence (steps/min)	Sedentary (%)	Standing (%)	Stepping (%)	Steps (/30mins)	STS (/30mins)	Cadence (steps/min)	Sedentary (%)	Standing (%)	Stepping (%)	Steps (/30mins)	STS (/30mins)	Cadence (steps/min)
All	85	8	5	102	2.0	74	46	24	20	488	2.0	81	30	24	34	796	3.0	82	25	26	37	857	3.0	88
Q1	59	0	0	2	0.0	63	20	10	7	138	1.0	69	7	13	14	326	1.0	72	9	18	20	464	1.0	72
Q3	99	23	14	336	4.0	87	78	39	38	982	4.0	92	62	37	57	1482	5.0	90	52	37	55	1589	5.0	96
Eating a meal [1]	67	18	11	236	3.0	74	46	25	24	584	2.0	85												
Snacking [2]	57	23	15	349	2.0	78	47	31	18	455	3.0	85												
Doing house chores [4]	67	19	11	254	4.0	64	64	22	9	180	3.0	69												
Hanging around [8]	63	19	10	248	2.0	77	49	18	17	392	2.0	82												
Homework/tuition [9]	86	10	6	110	2.0	68	79	14	3	32	2.0	58												
Listening to music [10]	84	11	6	110	3.0	67																		
Music lesson/playing instrument [11]	74	16	8	167	2.0	72	72	17	7	162	2.0	75												
Playing computer/ internet [12]	89	6	4	74	2.0	69	78	14	5	90	3.0	58												
Reading [13]	83	10	4	72	2.0	66																		
Shopping [14]	59	17	15	342	1.0	82	46	28	17	422	1.0	77												
Talking on phone [15]	82	13	4	84	2.0	72	73	15	3	35	1.5	84												
Watching TV or movie [16]	88	7	4	78	2.0	67																		
Riding in a car/bus [17]	56	21	17	420	2.0	86	55	25	19	502	2.0	86												
Travel by walking [18]	37	16	36	1017	3.0	93	24	27	39	1096	2.0	96												
Getting dressed [21]	73	16	7	133	3.0	68	72	19	7	140	3.0	64												
Getting ready (e.g. hair, make-up) [22]	52	30	12	235	3.0	70	52	31	15	248	3.0	69												
Sleeping [24]	100	0	0	0	0.0	64																		
Free period/breaktime [26]	40	31	28	731	1.0	90	40	30	29	732	2.0	86												
Sitting in class (lesson time) [27]	80	10	9	208	2.0	81	76	12	11	280	2.0	85												
PE class [28]	54	20	25	676	3.0	85	45	31	22	561	2.5	84	42	31	27	684	4.0	83	55	24	22	626	3.0	94
Dance [35]	52	23	24	488	4.5	72	35	30	25	488	4.0	73	44	27	26	583	4.0	74						
Jogging/running [41]	72	9	13	327	2.5	98	53	18	14	346	2.0	84	58	16	19	457	3.0	81	15	23	62	1897	4.0	102
Football [45]							38	26	39	820	3.0	78	8	18	70	1728	2.0	87	17	18	56	1616	1.0	90
Walking [51]	55	21	16	412	3.0	74	39	25	26	657	2.0	83	35	23	42	944	2.0	88	26	32	16	386	3.0	80